

CEBAF EXPERIMENT 93-044

Photoreactions on ^3He

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This experiment will use real photons to study three different phenomena in ^3He : the formation and propagation of nuclear resources in nuclear matter, three body force effects, and a Δ -isobar part of the nuclear wavefunction. With the Hall B photon tagger and the CLAS, each of these phenomena will be studied in exclusive reaction channels.

Recent total photoabsorption data on Be, C and U for photon energies from 0.2 to 1.1 GeV show strong suppression of the cross section ($\sim 35\%$) in the region of the D_{13} and F_{15} resonances, when compared with data from the free proton and the deuteron. However, the Δ resonance shows only Fermi-broadening effects. Because ^3He is intermediate in nuclear density and binding between the free nucleon (or the deuteron) and heavier nuclei, it constitutes an ideal case for studying the effect of the nuclear medium on the propagation of these resonances. We will study the degree of suppression of the D_{13} and F_{15} resonances in the photoabsorption cross section of ^3He by detecting the exclusive $N-\pi$ and $N-\pi-\pi$ reaction channels.

The study of the interaction of nucleons in the presence of other nucleons is a fundamental problem of nuclear physics. In ^3He , the two-body N-N force dominates the wavefunction at low energies (and hence long distances) to such a degree that the existence of a three-body component is still a subject of debate. We will look for manifestations of the three-body force at higher photon energies (up to 1.5 GeV photon energy, corresponding to a reduced photon wavelength of nearly 0.1 fm). The main difficulty of this measurement will be to distinguish the effects of true three-body forces from effects of sequential two-body processes. One likely signature is the “star” configuration in the reaction channel in which the three nucleons are emitted 120° apart with equal momenta in the center-of-mass frame, and no additional particles are produced. In this way the background from two-body processes is minimized.

The third objective of this experiment is to look at the small Δ -isobar part of the nuclear wave function. At low energies, the ^3He wave function is dominated by the NNN configuration; however, at higher energies the contribution of the Δ NN configuration has been calculated to be between a few tenths and several percent. The clearest signature of such a configuration is the direct knockout of a delta. To minimize contributions from the much more probable Δ -production events, we will look for Δ^{++} knockout events (Δ photoproduction from nucleons will contribute directly only to Δ^0 and Δ^+ production). These events will be identified by a missing-mass reconstruction analysis of $p-\pi^+$ events in the CLAS detector.

This experiment will require a tagged photon beam in the energy range 0.5 to 1.5 GeV, a cryogenic ^3He target, and the CLAS detector system. This experiment will run for 300 hours, of which 150 hours will be concurrent with Experiment 91-014.